# Underwater Remediation of Energetic Items/ Substances in a Water-Filled Limestone Quarry

## INTRODUCTION

Kerr Hollow Quarry (KHQ) is located approximately 1 1/2 miles South of the U.S. Department of Energy's Y-12 Facility and about 1000 ft. North of the Bethel Valley Road. The 3 acre quarry is approximately 55 ft deep and surrounded on three side by rock bluffs approximately 60 ft high. The quarry was used originally to provide construction material for the Oak Ridge National Laboratory (ORNL). It was closed in the latter part of the 1940's and permitted to fill with water. It was then used from 1951 to 1988 to treat water-reactive, corrosive, or ignitable waste from Y-12 and ORNL.

The waste was received in a variety of containers such as, drums, buckets, pipe sections, glass containers, tanks, and gas cylinders

AERIAL VIEW OF KHQ (Fig. 1)

# Report Documentation Page

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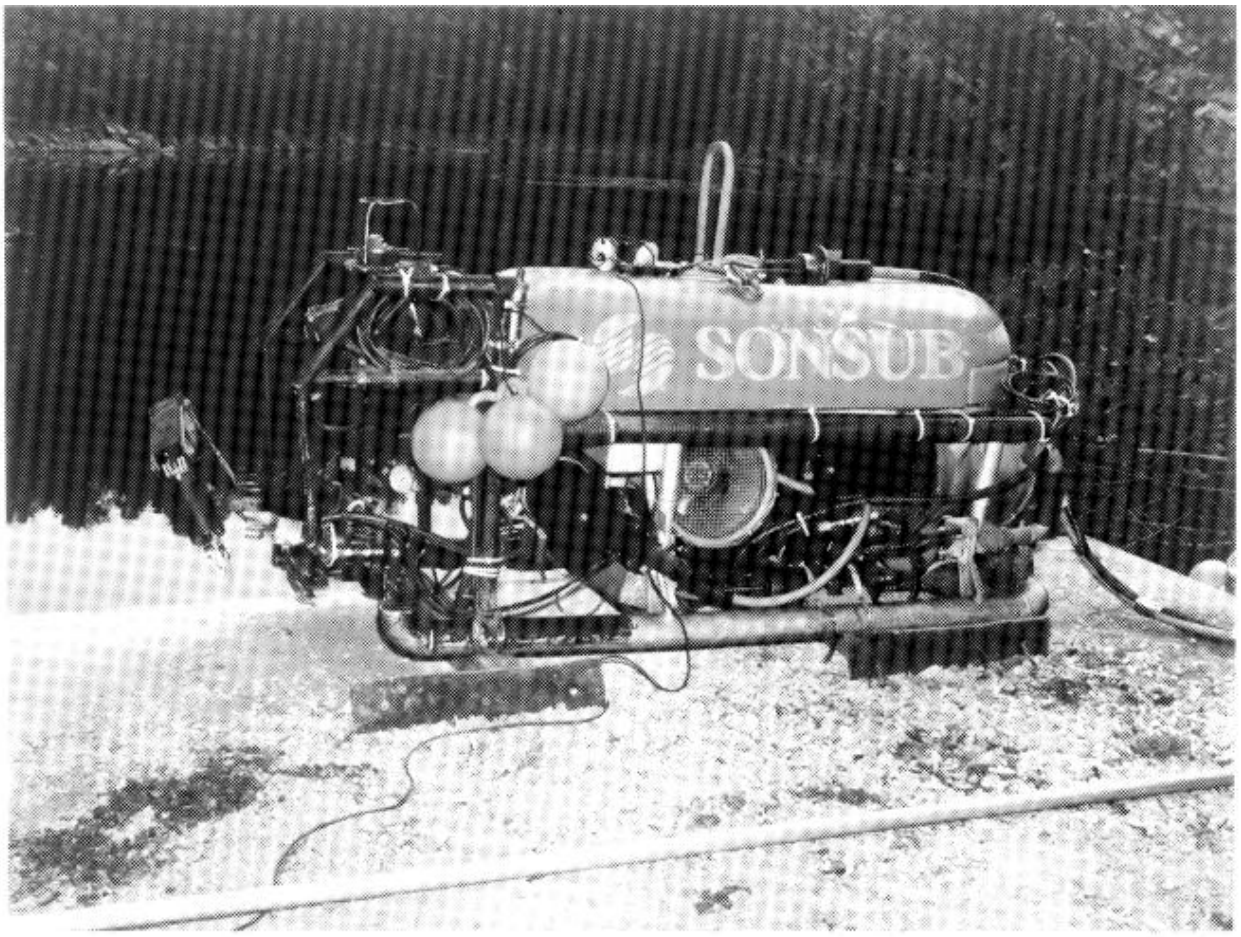
The normal waste treatment process consisted of dropping the waste down a chute and puncturing the container with high powered rifle fire fired by security guards and permitting the waste material to react with the water. Not all containers were punctured by rifle fire, many were heavy and immediately sunk to the bottom resting in piles on the quarry floor. In 1988 the Tennessee Department of Environment and Conservation (TDEC) issued a directive that the quarry was to be remediated.

In 1989 DOE formed, a priject team from its resources at ORNL & Y-12 to survey the quarry bottom. The survey consisted of using a small unmanned submarine or remotely operated vehicle (ROV) to video tape the waste material on the quarry floor. It was then estimated that between 3000 to 5000 items were in the quarry. In 1990 the team was also expanded to perform the remediation operations.

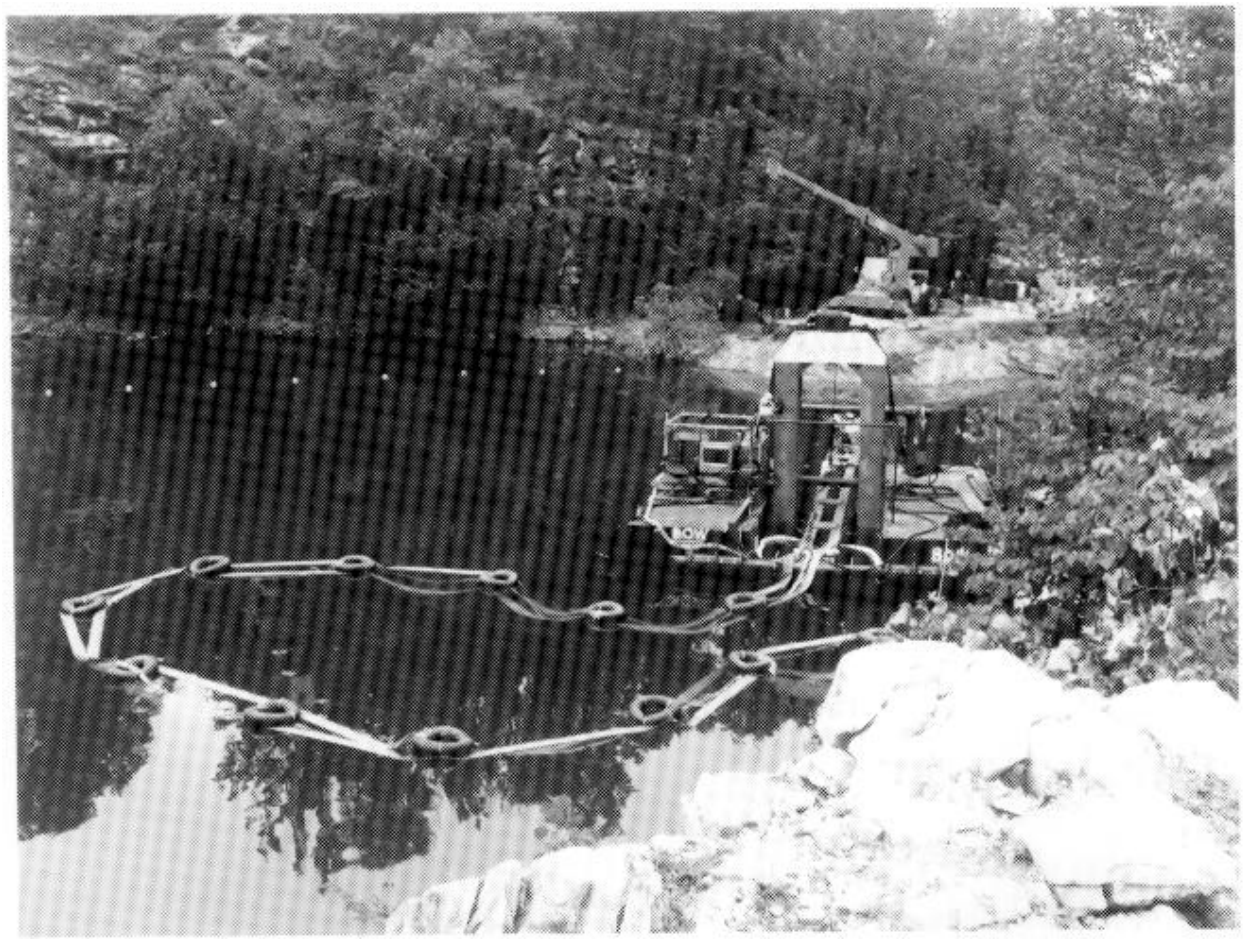
The site mobilization was completed in the latter part of 1990 and the remote remediation operations began immediately. The remediation equipment used in the remote operations consisted of the ROV, a large pontoon barge, and an underwater shredder. All of the equipment was remotely controlled from a control van located approximately 200 feet from the edge of the quarry. The ROV and the underwater shredder are shown in Fig. 2 and 3.




VIEW OF ROV (Fig. 2)

VIEW OF SHREDDER (Fig. 3)

The remotely operated pontoon barge was 30 feet long by 21 feet wide, configured in the shape of a “H”. A grapple was mounted in the center cross-span of the assembly. The grapple was used to pickup and transport waste material to the underwater shredder. The barge is shown in Fig. 4. The grapple was also used to transport the shredder chip basket that was mounted on a trolley rail directly under the shredder. The barge grapple would grasp the basket handle, extract it from under the shredder and then the barge would transport the container to an underwater transfer area at the edge of the quarry. The chip basket containing the shredded material could then be lifted out of the quarry with a crane and remotely dumped into B25 waste containers.



VIEW OF PONTOON BARGE (Fig. 4)

The removal of compressed gas cylinders required that the barge grapple be replaced with a special cylinder breaching grapple. The grapple consisted of a clam shell configuration with a hydraulically operated punch located in the center. The cylinder grapple would grab a gas cylinder and punch a hole. The cylinders could then be disposed of as waste material.

**REMEDIATION ACTIVITIES**

At the beginning of operations in the quarry a number of problems occurred, primarily associated with oil leaks from the hydraulic systems on the barge and ROV. These problems were eventually solved by improving preventative maintenance on the hydraulic systems and by installing diethylene glycol, an environmentally safe hydraulic fluid.

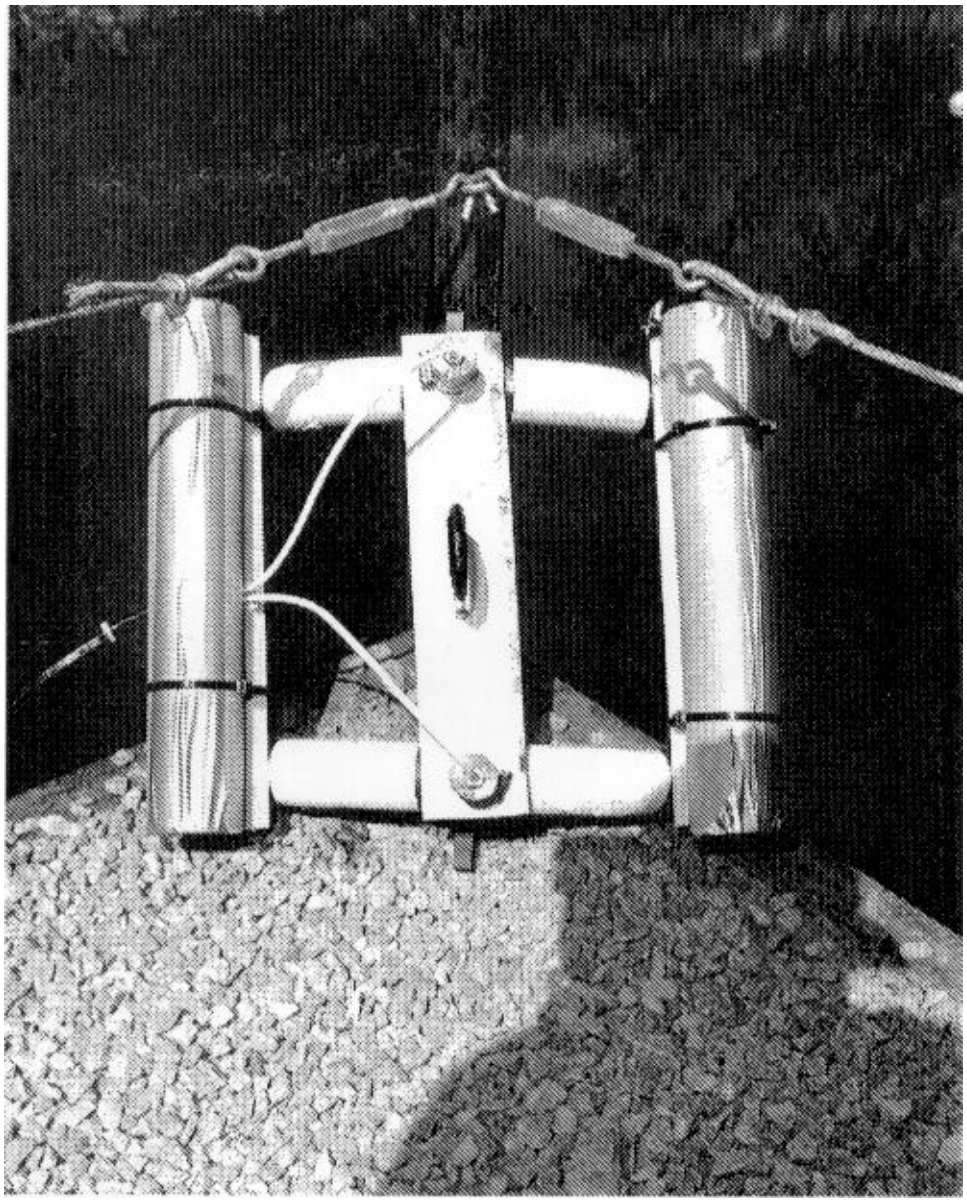
After solving the preliminary problems, operation were plagued by a series of previously unidentified events. In January 1991 low levels of radiological contamination were found on items removed from the quarry. The contamination was primarily in the form of depleted uranium. Since the contamination was unexpected, operations had to be temporary shut down for additional personnel training, implementation of new safety procedures and developing new waste control and disposal procedures.

In March 1991 pressurized gas cylinders were encountered. Also in March 1991 a container being shredded started to react with water indicating that it still contained unreacted alkali metal. The waste material migrated to the surface and continued to react with the water. These event required that gas cylinder breaching operations be temporarily suspended and modification made to the shredder feed hopper to prevent containers containing unreacted material from migrating to the surface.

In June, 1991 small unbroken glass vials were discovered in the shredded debris that contained a white powdery substance. Other glass vials contained unknown liquids. Since there was some concern that the material could be explosive, shredding was temporarily halted while a shielded glovebox was designed and built to permit safe personnel access during debris examinations.

In January 1992, shredding operations were again halted for fear of shredding a pressurized gas cylinder that could possibly contain poisonous gases. This required the development of a Toxic Gas Evacuation Procedure that had to be coordinated with Y-12 and local Civil Emergency Response teams. A new grapple was designed and fabricated. The new grapple contained two punches to create dual holes in every cylinder. The first hole was made with a fluted punch to permit the controlled release of gas from a pressurized container. This would permit potentially hazardous gasses to be absorbed into the water. The second hole was made with a larger punch to assure that the cylinder would fill with water to permit any residual gases to react with the water. The punched cylinder was then transported to an underwater cylinder basket where it remained for a minimum of ten days. The cylinder basket was then removed from the quarry with the crane and placed in a set-down zone at the edge of the quarry where the cylinders could be examined for radiological. contamination and the presence of hazardous gasses. The cylinders were then disposed of as radiological contaminated waste, since the inner portion of the cylinder could not be examined for radiological contamination.

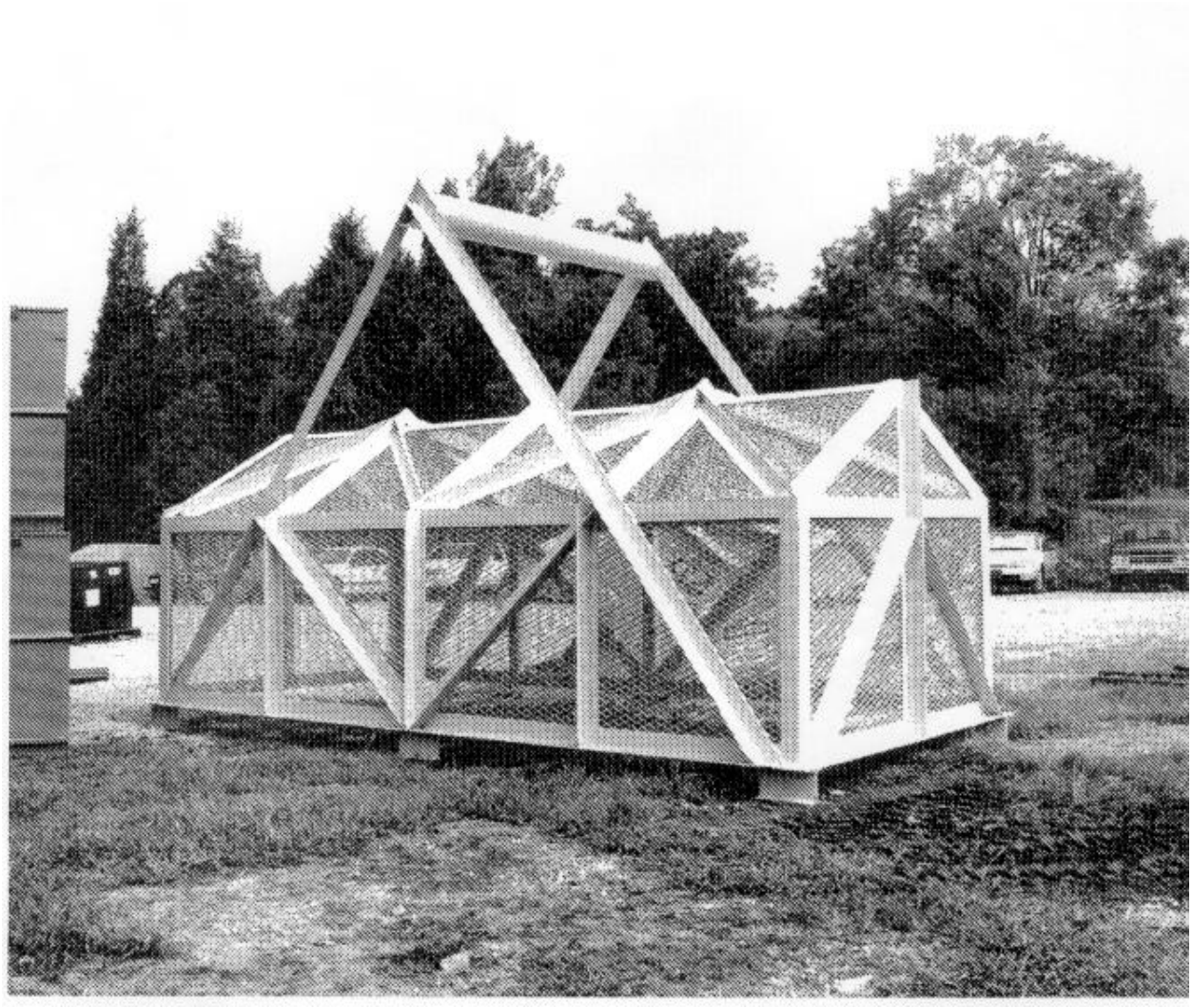
The quarry also contained many vessels that were too large to shred. These required that an explosive expert be contracted to breach the vessels. The first operation consisted of explosively breaching a minimum of four 1/2 inch diameter holes in the top of the vessels to insure that the vessel had been filled with water. Then a window was explosively cut into the vessel using shaped charges. One of these shaped charges is shown in Fig. 5. The windows were approximately 18 by 18 inches in size depending on the diameter of the vessel. These windows would permit examining the inside of the vessel with an underwater TV camera to verify that the container did not contain internal baffles or tubing. Examples of these explosively breached containers are shown in Fig. 6. If internal tubing or baffling was encountered, a pancake charge of explosives was placed into the tank and detonated to destroy internal structural members.



VIEW OF SHAPED EXPLOSIVE CHARGES (Fig. 5)


VIEW OF VESSELS EXPLOSIVELY BREACHED (Fig. 6)

Prior to setting of any of the underwater charges a large heavy explosive retention wire mesh metal basket was placed over the vessel. The underwater explosive retention basket is shown in Fig. 7. This mesh basket would prevent a vessel that contained a water reactive material (alkali metal) from filling with hydrogen and migrating to the quarry surface. All explosive charges were placed on the vessels utilizing the remotely operated ROV manipulator. The explosive retention basket was place over the vessel with the pontoon barge grapple.



VIEW OF EXPLOSIVE RETENTION BASKET (Fig. 7)

Shallow water operation started in early 1993 to remove waste material located in water too shallow to permit use of the barge grapple or ROV. To complete these operations a set of manipulator arms were attached to a telescoping boom mounted on the back of the pontoon barge. The waste material was then moved back into deep water for processing.

The quarry remediation was a very challenging and time consuming project. At the completion of the project in the latter part of 1993, more than 19,000 items consisting of shreddable material, open containers, gas cylinder, large vessels, and structures were safely removed from the quarry. The quarry is the first known underwater remediation project completed by remotely operated equipment. It remains a excellent example of how a hazardous clean-up operation can be completed in a safe manner by dedicated well trained operations personnel using remotely operated equipment.. The same technology and operations resources are available from the DOE Oak Ridge complex for application to remetiation of underwater unexploded ordenance (UXO).